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Monday, June 09, 2008

Commodities, currencies, and the St. Petersburg paradox

Hal Finney describes the surprising results of the Hotelling model of nonrenewable commodities:

> prices become much higher than the costs to produce the resource, the opposite situation from competitive markets in other kinds of commodities. Yet resource owners restrain production without the need for a cartel or any coordination.

This occurs because, under the Hotelling assumptions that the commodity is not renewable and cannot be substituted for (and of secure property rights, as David Friedman correctly points out) the commodity producer can choose between producing today or keeping it in the ground to produce tommorrow, with no fear of permanently losing sales to some competitor. Any sales lost to a competitor today draws down the competitor's fixed stores and can be recouped at any time in the future.

What the Hotelling model does not properly account for is that these very characteristics also make these goods great substitutes or hedges for money. Hotelling looks at a "fixed" or "prevailing" interest rate, but we should really be looking at expectations of future interest rates, taking into account expectations of future inflation. And we should account for changes in these expectations. If we do so, I think we will find the model to have high explanatory power (albeit not high predictive power, since we can't outguess the market about future monetary conditions -- but the search for predictive as opposed to explanatory power in economic models is largely futile anyway).

Imagine a world with two currencies C1 and C2 and two nonrenewable minerals, M1 and M2. C1 money supply outstrips money demand by 10%/year, and for C2 by 5%/year (in other words, C1 "inflates" or "falls" by 10%/year and C2 by 5%/year). If the price has not properly increased to account for future expected inflation, people will prefer holding M1 and M2 to holding either of the currencies. They will play "hot potato" with the currencies: as soon as they obtain a currency in trade, they will try to purchase M1 or M2 with it. All holders of M1 or M2 will demand a stiff premium to exchange their minerals for falling currencies. What premium will they charge? In theory, the inflation premium is infinite: it is a "net present value" calculation of the depreciation of the currency into the infinite future. In practice, (as with the St. Petersburg paradox, and because no commodity is perfectly nonrenewable or perfectly immune to substitution over the long term), the premium will just be very high: not only far higher than the cost of production, but also far higher than the Hotelling model under the assumption of no inflation. Inflation expectations will dominate the prices of M1 and M2 in C1 and C2.

Now imagine that inflation expectations change. If expectations of inflation in C2 to infinity go down from 5% to zero, we have in theory a change of net present value of revenue streams from M1 and M2 in currency C2 from infinity to zero, and in practice just a

About Me

Nick Szabo

"A premier thinker about history, law and economics, and the lessons they have for security." -- Adam Shostack, Emergent Chaos

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very high drop. It takes only a small change in inflation expectations to send the prices of M1 and M2 in C1 and C2 soaring or plummeting.

Since the standard Hotelling model predicts no abrubt price changes, and the monetary model does, the monetary model is a better choice for explaining the actual dramatic price movements in relatively nonrenewable commodities such as oil that we have observed.

Under imperfect information, since we have far better information about geology and technology than we do about future monetary conditions, and since uncertainty in monetary conditions produces far greater price changes than uncertainty about geology and technology, we can again conclude that abrupt changes such as we've seen are due almost entirely to changes in monetary expectations rather than in "fundamentals".

Furthermore, when we see dramatic changes across a wide variety of commodities, being led by the less renewable commodities like oil, Occam's Razor (or equivalently, basic probability) tells us that there are not 100 different explanations for why 100 different commodities have all gone up dramatically. Rather, we need only two quite related explanations: changes in inflation and inflation expectations for the currencies they are priced in.

Two commodities that come relatively close to being Hotelling nonrenwable commodities are gold and oil. For gold, the above-ground stockpiles are far greater than the annual production. For oil, the below-ground stockpiles are far greater than the annual production. The price of gold has always historically been dominated by its role as money, monetary substitute, or hedge, or equivalent, and the price of oil is also coming to be so in an age of floating currencies and in the current decade of rising inflation expectations. When we realize that Hotelling nonrenewable goods make better long-term stores of value than less renewable commodities, we can explain why, while all commodities have dramatically risen over the last three years, the surge in oil has been disproportionately dramatic, and even more dramatic than the rise of gold: the rise in oil combines an increasing use of oil as an inflation hedge (mostly by the producers themselves curtailing production), which effects oil but not gold (which has long been used this way), with increasing inflation expectations (which effect both gold and oil, and other commodities to a lesser extent).

It is often noted, in rebuttal to the theory that the falling dollar is mostly responsible for commodity price rises, that the dollar has fallen less gainst the euro, or against a basket of other currencies, than oil and many other commodities have risen in dollar terms. In other words, oil and most other commodities have also risen in euro terms, just less so. There are a number of problems with this argument as a way of dismissing monetary causes.

The first problem is that these statistics only record falls relative to other currencies. It assumes there is some currency out there, or some basket of currencies, that is a stable standard of value that we can measure against. But there isn't. It's quite possible, and indeed currently quite probable, that the euro etc. supply has also inflated (relative to demand for the currency), so that all major currencies are falling relative to a hypothetical stable standard of value. They are just falling by on average less than the dollar is falling. Just because there is no standard to measure them against doesn't mean they can't collectively fall (or equivalently, that they can't all collectively inflate, as defined by greater supply, less demand, or both for the currency).

Also important is that the euro is too new and untested by time, and other currencies too small, for them to make good substitutes for the dollar. So when the dollar starts becoming dodgy, people turn to commodities to hedge debt denominated in unreliable currencies (which currently means practically all debt -- not just "junk" debt). So we have three monetary factors each causing commodity prices in dollars to rise:

(1) More dollars chasing the same (in the short term relatively inelastic) supply of commodities. This directly effects only the dollar prices.

(2) Greater demand for commodities as a substitute or hedge for currency-denominated debt, to hedge against further possible

Blog Archive

- ► 2018 (1)
- ► 2017 (3)
- ► 2016 (4)
- ► 2015 (3)
- ► 2014 (3)
- ► 2013 (3)
- ► 2012 (8)
- ► 2011 (12)
- ► 2010 (9)
- ► 2009 (29)
- ▼ 2008 (55)
  - ► December (2)
  - ► October (2)
  - ► September (4)
  - ► August (9)
  - ► July (4)
  - ▼ June (6)
    - Commodity hysteria -- an overview
    - State vs. anarchy -- the false dichotomy
    - Green beards and master genes
    - Commodities, currencies, and the St. Petersburg pa...
    - U.S. Supreme Court breathes new life into first sa...
    - The war against retirees
  - ► May (6)
  - ► April (4)
  - ► March (10)
  - ► February (5)
  - ► January (3)
- ► 2007 (47)
- ► 2006 (130)
- ► 2005 (44)

inflation. Small changes in inflation expectations, as discussed above, can have large impacts on commodity prices. This increases commodity prices in all currencies.

(3) A flight to safety from the credit crunch, creating more demand for safer forms of debt (e.g. U.S. Treasuries), and thus even more demand for commodities to hedge the currency risk from holding that debt. This increases commodity prices in all currencies.

No "manipulation" or irrational "speculation" is required to explain commodity prices, and there may not even be a bubble (although a bubble could easily arise under such conditions of high uncertainty). Rising commodity prices, and in particular the disproportionate surge in oil, are mostly or entirely just a rational and efficient response to the poor state of the world's floating currencies and the credit crunch.

(This post is based on previous comments I have made at other blogs, including in response to Hal's post linked to above).

Posted by Nick Szabo at 4:50 PM

2 comments:

nick said...

Here's a comment I just made on another blog to illustrate how rapidly commodity prices can change with small changes in inflation expectations (you can check the result using the "NPV" or similar function in your spreadsheet):

Increased expectations of inflation in future decades, from 1998 (near the end of a decade when deflation was the main worry) to today (even Alan Greenspan said in his recent book to expect 4.5%/year from here on out, and that was well before the Bear Stearns bailout), can easily account for a factor of 14 increase. For example, a Hotelling nonrenewable commodity for which there are no changes in expected consumption (assume the expectation covers the next 100 years), but there is a change in expected inflation from 1.75%/year over that time to 4.50%/year over that time, gives us a factor of 14.3 increase in the commodity price.

Of course, as the St. Petersburg paradox suggests, the 100 year figure is somewhat arbitrary. Restrict the time horizon to 50 years and the inflation expectations have to increase more dramatically, e.g. from 1.0% to 6.5%, to translate into a factor of 14 increase in the price of a Hotelling commodity. At the other extreme expectations over 200 years need to only increase from 2.6% to 4.0% to account for that factor of 14.

If you are a Saudi prince who can expect his great-granchildren to still own a share of the Saudi oil fields in 200 years, the 200 year figure is appropriate, but in most other cases property rights are less secure and shorter timeframes are appropriate. Furthermore, there are too many technological jokers over 200 years to expect the non-substitutability assumption to hold (for example, somebody might genetically engineer a cheap biofuel).

3:53 PM

nick said...

On the subject of substitutability, more comments I made elsewhere:

The problem [with substitutes like coal gasification, tar sands, etc.] is that higher inflation expectations must be built into cost estimates for them. It's no good to say that coal gasification cost only $80/barrel last year, for example, and so it must be cheaper than oil at $140/barrel. One has to figure out how much a coal gasification plant will cost over its future lifetime given the higher

expected inflation. The cost ratio for coal gasification or extracting tar sands to the cost of extracting Saudi oil hasn't changed, it is still more than a factor of 10 higher. As inflation spreads from gold and oil (where it appears first) to other commodities, and then to wholesale prices, then to retail prices, then to labor costs, we will see the nominal costs of tar sands, coal gasification, nuclear power, wind power, and so on catch up to the nominal price of oil. The relative real costs of all these sources haven't changed much, and won't change much, unless there is some joker discovery like a great improvement to biofuels due to genetic engineering. (It is true that the nominal attractiveness of these alternatives to oil increases the R&D into alternatives and thus increases odds of such a joker occuring per year). Nevertheless, it's probably the case that only nominal relative costs, rather than real relative costs, have and will substantially change due to inflation expectations hitting gold and oil prices before they hit other kinds of prices.

3:56 PM

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